VISUALISING SPEECH: USING ULTRASOUND VISUAL BIOFEEDBACK TO DIAGNOSE AND TREAT SPEECH DISORDERS IN CHILDREN WITH CLEFT PALATE

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BACKGROUND

Problems with producing clear, intelligible speech can occur in cleft lip and palate (CLP), even after successful surgery to repair the palate.

Current methods of assessment:

- Perception-based phonetic transcription
  - unreliable in CLP due to range and type of errors[1]
- Electropalatography (EPG)
  - recommended by Royal College of Speech and Language Therapists
  - can reveal covert contrasts and errors
  - requires custom-made artificial palate
  - images only tongue-palate contact from the alveolar region to the boundary of the hard and soft palate
- Advantages of Ultrasound Tongue Imaging (UTI) over EPG:
  - cheaper
  - images from near the tongue tip to the root
  - pharyngeal articulations, common in CLP, are visible
  - does not require individualised equipment
  - can continue to be used as child grows or following surgery

Therapy

Ultrasound can be used as a visual biofeedback tool (U-VBF), to provide children with real-time feedback on their articulations. This can lead to quick remediation of deeply engrained articulatory patterns demonstrated by a growing evidence base (~30 small studies, e.g.[2, 3, 4]). However, only one small study has focussed on the CLP population, with just two children with sub-mucous cleft[2].

AIMS

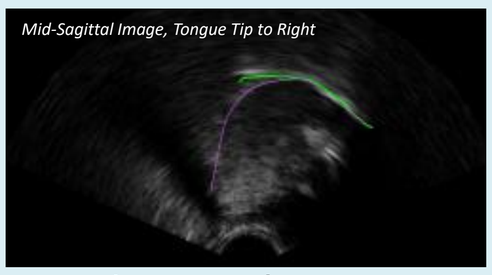
STUDY 1: Assessment

To develop an ultrasound-based diagnostic assessment for identifying imperceptible speech errors in children with cleft palate which will be a viable tool for clinical practice and circumvent the practical problems associated with EPG.

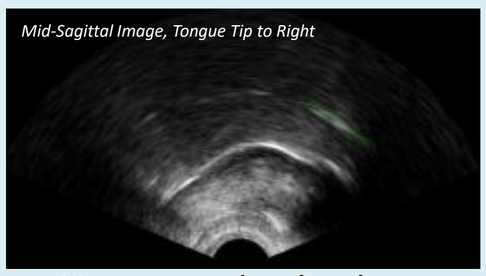
STUDY 2: Intervention

To evaluate the effectiveness of U-VBF in remediating speech disorders in CLP

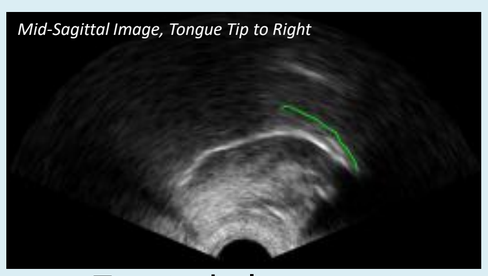
ERROR TYPES REVEALED BY ULTRASOUND: *Examples form Children with Speech Sound Disorders.*



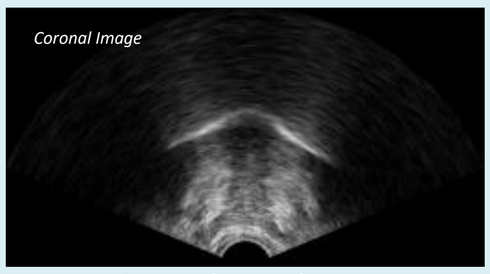
Increased contact



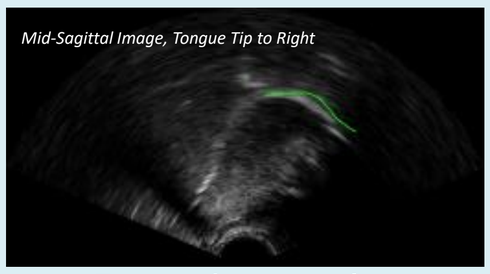
No contact/undershoot



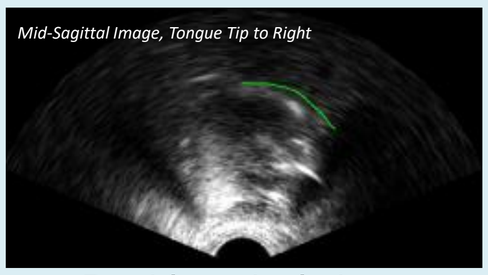
Fronted placement



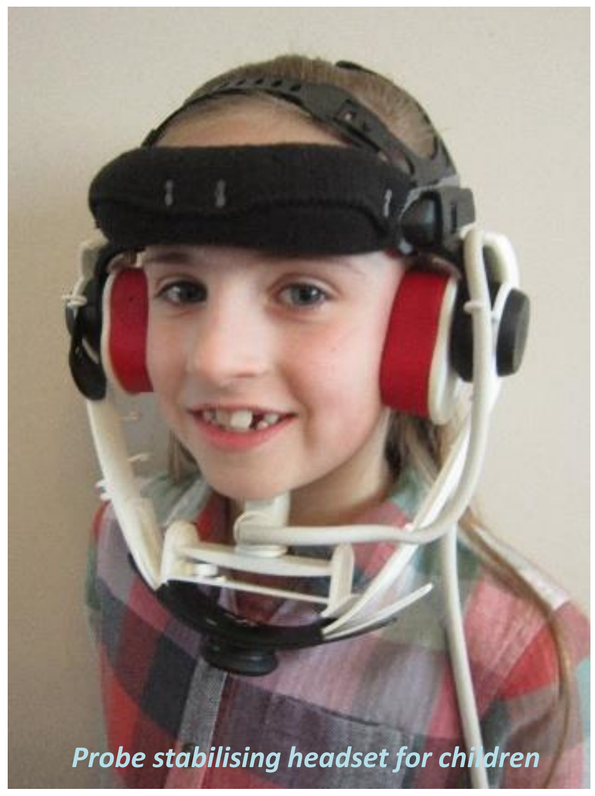
Complete closure
(Loss of groove - coronal)



Retraction to velar or
palatal placement



Double articulations



Probe stabilising headset for children

	PARTICIPANTS	DESIGN	ANALYSES

Study 1 Assessment	~48 children
	Aged 3-15
	Non-syndromic or syndromic CLP
		• Head set stabilises probe under chin
		• Micro high-speed cineloop system at 100fps over a 150 degree field of view
		• Data collected:
		  • spontaneous counting
		  • all consonants in /aCa/
		  • minimal sets contrasting common substitutions
		  • Sentences from the CleftNet Protocol
			• Perceptual analysis - phonetic transcriptions
			• Visual analysis of ultrasound – documented live
			• Quantitative analysis of ultrasound using Articulate Assistant Advanced software[5] and a range of measures:
			  • Dorsum Excursion Index
			  • LOC_{a-i}
			  • Modified Curvature Index
			  • Nearest Neighbour Distances

Study 2 Intervention	~ 8 children from study 1 with lingual speech errors	• Single subject multiple baseline across participants • 10x 45 minute weekly therapy sessions • Target specific untreated probes: 3 baseline, mid-therapy, post-therapy, 3 month post-therapy	• Probes, wordlists and DEAP transcribed by SLT blind to the intervention time point and scored for % segment on target • Celeration lines and 2SD band methods to determine progress statistically within speakers

References

[1]S. Howard, “Phonetic Transcription for Speech Related to Cleft Palate.,” in *Cleft Palate Speech: Assessment and Intervention*, Chichester, Wiley-Blackwell, 2011, pp. 127-144.

[2]Z. Roxburgh, J. M. Scobbie and J. Cleland, “Articulation therapy for children with cleft palate using visual articulatory models and ultrasound biofeedback.,” in *Proceedings of the 18th ICPhS.(0858).*, Glasgow, 2015

[3]J. L. Preston, N. Brick and N. Landi, “Ultrasound biofeedback treatment for persisting childhood apraxia of speech.,” *American Journal of Speech-Language Pathology,* vol. 22, no. 4, pp. 627-643, 2013.

[4]J. Cleland, J. Scobbie and A. Wrench, “Using ultrasound visual biofeedback to treat persistent primary speech sound disorders.,” *Clinical linguistics & phonetics,* vol. 29, no. 8-10, pp. 575-597, 2015.

[5]Articulate Instruments Ltd, Articulate Assistant Advanced User Guide: Version 2.14., Edinburgh: Articulate Instruments Ltd., 2012.